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ECONOMIC BARRIERS TO RECYCLING

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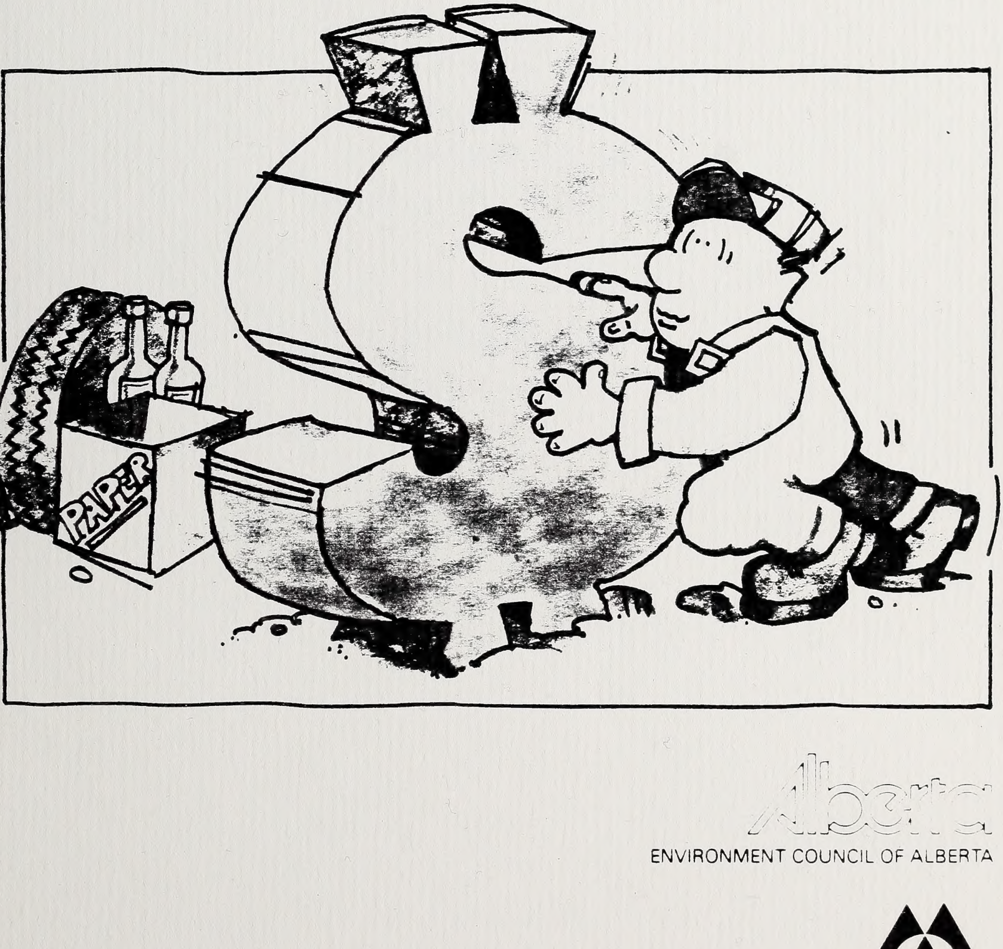

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ECONOMIC BARRIERS TO RECYCLING

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November 1985

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This report may be cited as:

Webb, C. 1985. *Economic Barriers to Recycling.* ECA85-18/IB2.
Edmonton : Environment Council of Alberta. 36 pages.

ECA85-18/IB2

Preface

The Environment Council of Alberta (ECA) has been requested by the Alberta Government to hold public hearings on recycling in Alberta. One of the major purposes of the hearings is to inquire into obstacles to recycling and to recommend measures to improve the economics of recycling in Alberta.

Economic Barriers to Recycling is one of several reports that the ECA has prepared for persons interested in participating in the hearings. These reports are not intended to be thorough references on recycling, and they do not make recommendations on the subject matter. The intent of these reports is to stimulate thinking about recycling, after which hearing participants are invited to provide the panel with their concerns and opinions about the subject and with their experiences with recycling projects already in place. This input is essential to the ECA's development of policy recommendations that will allow recycling to function at an appropriate scale within the Alberta economy.

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1. INTRODUCTION

Two words in the title of this report, economics and recycling, require definition before delving into the subject matter of *Economic Barriers to Recycling*. Both words are often interpreted differently, and misunderstanding can be avoided by defining them at the outset of the report.

Economics is the study of the management of limited resources for the purpose of attaining maximum satisfaction of human material wants. Many of our everyday concerns, such as employment, inflation, and even pollution, are economic issues. These issues affect all of us as individuals, but economic problems are usually examined from a wider, societal perspective. What is good for an individual may not be good for society, a point that surfaces later in the report when market failure is discussed as a cause of pollution. Clearly, economic benefits or profits do not refer solely to business profits, although ideally it is preferable for individuals and the whole of society to benefit, financially and otherwise, from actions taken by individuals or governments. It is a broad interpretation of the word economics that is generally used throughout the report.

Recycling is also a term that may be unclear to some readers. Recycling has several meanings. In addition to the reprocessing of materials, recycling is used to mean reuse of manufactured products, and byproduct generation from recovered materials. Returnable bottles are examples of reuse, while power generated from recovered incinerable materials is an example of byproduct generation. In this report, the word recycling is used to cover all three cases, although, depending upon the material being discussed, only one or two of the definitions may be implied when the term is used.

Economic Barriers to Recycling deals with topics that are diverse and potentially complex. However, the report is intended as an introduction to the variety of issues and approaches related to recycling, and only an overview of the topics is presented. Readers wanting more detail are encouraged to consult the literature sources listed at the end of the report.

Subsequent to this introduction, *Economic Barriers to Recycling* discusses some environmental advantages to recycling. Part two of the report briefly describes the flow of materials in the economy. In a market economy the flow of materials is driven by supply and demand, but for a variety of reasons supply of, and demand for, recycled materials may be low. Section three continues the description of some of the environmental benefits from recycling that are introduced under materials flow.

Part four of the report describes some of the obstacles to recycling, and at greater length deals with policies that can be used to enhance the prospects for recycling. Some explanation of how the alternatives work is presented, as well as advantages and disadvantages of the various policies. Depending upon the reader's perspective, some of the policy devices described may be appropriate for application in Alberta.

Throughout the report there are terms (in italics) with which the reader may not be familiar. These terms are defined in the glossary at the end of the report.

2. MATERIALS FLOW

The economy depends upon resources that are provided by the environment, and in turn the state of our environment is affected by the types and levels of activities at work in the economy. The natural recycling of elements ensures the survival and development of ecosystems, and, similarly, the recycling of goods and materials within economies has the potential to enhance the development of economies and prolong the benefits we derive from material inputs.

The relationships between the environment and the economy can be illustrated by a simple model (Figure 1). The box labelled the "production sector" represents all industries engaged in the extraction of materials from the environment, the manufacture of marketable goods and services from the extracted materials, and the transportation and distribution of the manufactured goods and services throughout the economy. The goods and services go to individuals acting as consumers, labelled in Figure 1 as the "household sector." The household sector provides capital and labor, in return for money, which is used to purchase goods and services from the production sector (Freeman et al. 1973).

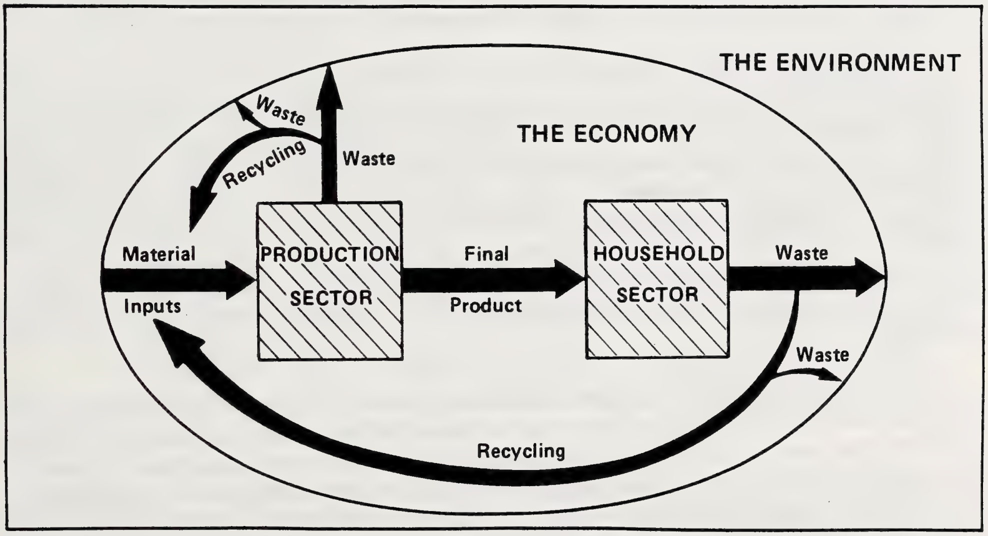

Figure 1. Materials flow and the economy

Source : Adapted from Freeman et al. 1973: 12

Note: No direct relationship to quantity of materials should be inferred from the relative size of the arrows.

Wastes are generated by both the production and household sectors of the economy and are returned to the environment. In Figure 1, the economic system is enclosed by the environment and is dependent on it. The environment provides the economy with the materials necessary for production and consumption in the economy, and it carries away the wastes generated by the economy. The environment is able to assimilate wastes returned to it, but when they are pumped into the environment at levels exceeding the ability of the environment to decompose or harmlessly disperse them, pollution and environmental degradation result (Freeman et al. 1973).

There are four basic technological options for reducing the environmental impact created by waste deposited in the environment:

1) reduce the throughput of materials and energy

2) treat the wastes to make them less harmful to the environment

3) choose the time and place of waste discharge in order to minimize the damage, and

4) enhance the capacity of the environment to assimilate wastes (Freeman et al. 1973).

A comprehensive management strategy would include elements of all four options. However, reducing throughput would also reduce the need for options 2, 3, and 4, so where feasible it should have high priority as a waste management strategy. The diminished need to attend to options 2, 3, and 4 probably would entail reduced waste disposal costs, but the main attraction of the reduced throughput strategy is that it attempts to actually reduce pollution problems rather than mitigate their consequences.

Materials throughput can be lowered by reducing the level of economic activity, but this is not likely to be a socially acceptable alternative since it results in a lower standard of living. Decreasing the input requirements for any level of Gross National Product (GNP), that is, a country's total output of goods and services, is a more realistic way of reducing materials flow. Input requirements can be acceptably reduced by improving technical efficiency, changing the composition of the GNP to goods that generate fewer wastes, and recovering and recycling materials (Freeman et al. 1973). Indeed, the economic history of the last two decades has seen an increasing trend in the direction of reducing input requirements, for example, more fuel-efficient automobiles and recyclable aluminum beverage containers.

A recycling loop that illustrates a diversion of waste materials from the environment to the production sector also is illustrated in Figure 1. The illustration shows that recycling also generates wastes. Conceivably, recycling could generate more waste than it diverts to the production sector, but, as will be described later in the report, the net waste generated by recycling is generally lower than that generated by direct disposal to the environment. Recycling, then, should allow a better balance to be struck between society's need for goods and services provided by the environment and the demand for environmental quality.

Like virgin materials, the flow of recycled materials through the economy is driven by supply and demand, with the value of the materials determined by conditions such as location, quality, and quantity. In most cases there are more virgin materials than recycled materials moving through the economy because virgin materials are relatively more attractive in terms of quality and quantity and, in a country like Canada, often in terms of location. Materials that can be recycled are often highly dispersed and low-grade (that is, they contain impurities) so that the costs of accumulation and readying for remanufacture can be high. The investment in capital that would be required for manufacturing industries to accept recycled as well as virgin materials also favors the continued use of virgin materials.

Such difficulties in accumulating waste materials at a reasonable cost are universal. For Alberta, however, accumulating wastes cheaply is especially difficult because the province is not as intensively developed as places like the Toronto-Hamilton area in eastern Canada, or the American Eastern Seaboard. There, the existence of many large urban centers in close proximity, concentrations of industry, and well-developed transportation networks make recycling easier. Probably only Edmonton and Calgary can now generate wastes on a scale large enough to justify the heavy capital expenditures required for recycling facilities (Alberta Environment 1979).

However, the negative effect of distance barriers is subject to other considerations, such as the relative supply and value of the inputs. One example of this is provided by the IPSCO steel mill in Regina, which buys 50 percent of the scrap steel it uses from locations outside western Canada from as far away as Buffalo, New York and Sorel, Quebec (Backman 1984). In this case, the absence of readily accessible sources of iron ore improves the competitive position of scrap as a raw material in the steel industry.

Higher relative profitability and greater flow of virgin materials may also result because the finished goods are priced at a level which does not reflect the social cost associated with production. When third parties are adversely affected by a production activity, for example, they bear costs in excess of those calculated by the producer. More goods are produced and consumed than would be the case if the social costs to the third parties were included in the product cost (Freeman et al. 1973). Of several variables tested, the failure to completely cost the use of primary materials was judged to be the greatest barrier to recycling by Canadian recyclers (Taylor 1982). When all costs are not accounted for, resources are not allocated to their best use and the markets are considered to have failed.

The preceding look at the flow of material in the economy proposes that recycling offers prospects for a cleaner environment, a proposition that is elaborated upon in the next section of the report. Recycling also offers prospects for the maintenance of a high standard of living. Conceivably, with an active recycling program at work in society, the money that would otherwise have to be spent on cleaning up the environment could be spent in other ways, such as on capital to maintain or enhance economic growth.

A positive correlation between standard of living and commodity recycling might be expected if money saved by recycling was spent to maintain or enhance economic growth. Table 1 ranks various countries by percentage recovery of three commodities — steel, aluminum, and paper — and per capita income, which is used as a proxy measure of standard of living. The correlation for steel is statistically significant, which is not surprising in view of the important part that steel plays in industrial economies and the increasing scarcity of economically mineable ore deposits. However, the rank correlations for aluminum and paper

Table 1. Rank correlation between standard of living and recycling of steel, aluminum, and paper

Scrap Steel			Aluminum			Paper		
Country	Rank Recovery %[1]	Rank Income/Cap[2]	Country	Rank Recovery %[3]	Rank Income/Cap[2]	Country	Rank Recovery %[4]	Rank Income/Cap[2]
Belgium	1	3	Netherlands	1	5	Mexico	1	12
United Kingdom	3	7	Italy	2	13	Japan	2	7
United States	3	4	West Germany	3	2	Netherlands	3	4
Netherlands	3	5	United States	4	4	Spain	4	9
Japan	5	6	United Kingdom	5	12	South Korea	5	13
Poland	6	11	France	6	6	Hungary	6	10
Czechoslovakia	7	10	Japan	7	11	West Germany	7	1
Spain	8	9	Switzerland	8	1	Sweden	8	2
West Germany	9	1	Norway	9	7	Italy	9	8
Italy	10.5	8	Sweden	10	3	Brazil	10	11
Sweden	10.5	2	Australia	11	6	Australia	11	6
Brazil	12	12	Canada	12	8	United States	12	3
India	13	14	Austria	13	9	Canada	13	5
Soviet Union	14	13	Brazil	14	14	Philippines	14	15
China	15	15	Mexico	15	15	Nigeria	15	14
	$r_s = .633$[5]			$r_s = .396$			$r_s = .111$	

Sources : [1] Chandler 1983 : 37
[2] The World in Figures 1981 : 13
[3] Chandler 1983 : 25
[4] Chandler 1983 : 13

[5] Spearman's rank correlation coefficient

Note : The ranks of some countries change with the product being examined because the mix of countries being examined varies from one product to the next.

are not statistically significant. These data imply that the economic advantages associated with recycling are not widely experienced by those who, first, are able to benefit most from recycling, second, can most afford to recycle, and, third, benefit most from the use of virgin materials. Generally it seems that recycling is not being used to the degree that it could to maintain or enhance economic growth. A mixture of economic and cultural explanations that are not evident from Table 1 account for the patterns of recycling in the world, but the explanations are too detailed for the purposes of this report. Readers may consult Chandler (1983) for a synopsis of the explanations.

One surmises that in an open economy recycling will be undertaken where it is economically advantageous. For some commodities there is already a substantial recycling industry in the province, although this existing recycling industry gets little recognition for the environmental benefits it confers. Indeed, the recycling industry has to compete against government-subsidized waste disposal systems that take potentially recyclable materials and mix them with unmarketable wastes, which increases the difficulty of recovery. For example, newspapers and metals are collected along with the household garbage and mixed wastes. Although the relatively high costs of accumulating and remanufacturing recyclable materials partially account for the failure to recycle many commodities, failure to price goods and raw materials at the full social cost is probably at least as responsible for the failure of more recyclable materials to be exchanged in the marketplace.

3. ENVIRONMENTAL BENEFITS

FROM RECYCLING

Because of their economic value, recycled materials are exchanged nationally and internationally, and markets for many recycled commodities exist. Canada's part in recycling efforts is not insignificant, particularly given the disincentives to recycling that exist in Canada, such as low and scattered population densities, Canada's role as a raw material supplier, and the relative abundance of disposal sites. Two of the better studied commodities which illustrate the scale of recycling in Canada are paper and glass.

From 1978 to 1982 the amount of waste paper recovered ranged from 866,000 tonnes in 1978 to 1,034,000 tonnes in 1981. During the same time period, imports of waste paper, mainly from the United States, ranged from 628,000 tonnes in 1979 to 416,000 tonnes in 1982. Exports rose from approximately the 111,000-tonne level in each of the years from 1978 to 1981 to 151,000 tonnes in 1982. The value of waste paper exported from Canada in 1982 was about $30 million (U.S.); two-thirds of the receipts came from the United States, and most of the remaining one-third came from Pacific Rim countries, notably Thailand (Pilsworth 1984b).

About 63,000 tonnes of glass were recovered in Canada in 1980. Comparatively small amounts of *cullet* are imported into Canada from the United States, mainly from the states of Michigan, New York, and Vermont. Alberta has a good record within the Canadian glass recycling community. Not including refillable beverage containers, the 29,500 tonnes of glass recovered in Alberta in 1982 represents about 47 percent of the Canadian total (Pilsworth 1984a). The leadership shown by Alberta in glass recycling is due to our deposit-refund system for refillable and non-refillable beverage containers. Not only has the deposit-refund in Alberta been effective as a waste management strategy, but it has created positive spin-offs for Alberta's economy by creating new employment opportunities, and it has established an infrastructure that could serve as a base for other recycling programs (Hare 1983).

Canada and other countries that practice recycling already enjoy environmental benefits, which are likely to continue in the future, resulting from reduced materials flow within their economies. As virgin materials become scarcer and more costly to process, recycling will become more prominent, since there is still a large gap between amounts potentially recoverable and those currently recovered. As is the case for copper and iron/steel (Radetzki and Van Duyne 1985), and likely for other commodities, the share of demand met by recycled products is expected to increase even with decelerated economic growth.

There are many areas where the environmental benefits resulting from recycling can be defined. Five major areas are discussed briefly in this section: energy, air and water, raw materials, litter, and reduction in solid waste generation. For each of these areas, the discussion of environmental (and economic) benefits begun in the materials flow section of this report continues, and shows that while recycling may not simultaneously benefit all components of the environment, there is little doubt about its overall benefit.

ENERGY

Conservation of energy is one important criterion by which to measure the value of recycling. Of course, energy is required to collect and reuse materials, so only if less energy is used when recycling is practised does recycling conserve energy. However, experience from around the world indicates that energy conservation results when recycling is practised. In some cases, energy savings of 90 percent have been calculated (Wolbeck 1977).

The magnitude of the energy savings will vary according to the type of recycling being practised and the material being recycled. Reuse should have more environmental benefit than remanufacturing of recovered goods, since energy is not needed to remanufacture the product. The value of reuse or reprocessing versus the value of incineration is not as intuitively clear. Each situation probably requires a comparison between the useful energy that can be derived from incineration and the energy that can be saved by reuse or reprocessing (Kelly 1974). However, recovering energy from waste may provide a beneficial alternative where reuse or reprocessing is not possible.

One might expect that the energy savings that result from recycling in a certain way will be reflected in the economic value of the recycled good. Reused or remanufactured goods often have more economic value than materials used for byproduct generation (for example, energy from waste) (Environmental Resources Ltd. 1978), likely in part because of the energy that does not have to be expended to procure and process raw materials.

In general, when producing materials from a secondary source, the largest energy savings are achieved in the production of metals. The large savings result because the use of energy for mining and processing is avoided. Savings in the production of plastics, rubber, and paper are lower. Energy savings in the production of glass from cullet are lower yet, though with reuse of containers there are potentially considerable energy savings (Environmental Resources Ltd. 1978; Cook 1976).

The calculated energy savings depend upon which product is being examined and the method of accounting that is used. Paper recycling provides an example of how results can differ according to the accounting procedure used. When calculating the energy that can be saved by paper recycling, it is important to distinguish between the total amount of energy used and energy that is purchased. Forty-five percent of the energy required for the paper industry can be self-generated by burning products from the manufacturing process such as bark and spent pulping liquor. When the self-generated energy is considered to be equivalent to purchased energy, then less energy is used when paper is recycled, regardless of the grade of paper manufactured (newsprint, fine paper, boxboard, or linerboard). However, when comparisons of only purchased energy are made, whether or not recycling uses less energy depends upon the paper product being manufactured. Among studies reviewed by the

Organisation for Economic Co-operation and Development (OECD) (OECD 1979), newsprint was determined to be the only paper product that created energy savings whether purchased energy or total energy consumption was being considered.

Bottle returns and reuse also illustrate energy savings. Manufacturing accounts for a large proportion of the total energy required to produce non-returnable beverage containers; for example, for aluminum beer cans the proportion is 93 percent, and for glass beer bottles 67 percent. The total amount of energy used in the manufacture of returnable bottles exceeds that for the non-returnable bottle due to the greater weight and durability of the returnable bottle (OECD 1978). The energy, however, is amortized over the life and number of trips of the returnable bottle, so that the energy requirements are comparatively low (OECD 1978). Table 2 compares the energy requirements for several types of non-returnable containers against the returnable glass bottle. Various studies provide different data, but the relative rankings are similar. Returnable systems require the least energy, followed by the bimetallic can and non-returnable bottle. The aluminum can required the largest amounts of energy in all studies (OECD 1978).

Energy consumption, however, could also limit the amount of recycling that is economically feasible. Energy consumption as a limitation to recycling can be expected with highly mixed wastes having low concentrations of valuable materials or with highly dispersed wastes (Wolbeck 1977). In those cases, other reasons would be required to justify recycling. For example, securing peoples' health could justify the recycling of small amounts of widely distributed hazardous wastes even though recycling them might be energy consumptive and costly.

Table 2. Total Energy Requirements of Container Systems for Soft Drinks

Container System	Therms* per 100 Litres
12 oz. aluminum can	18.7
12 oz. bimetallic can	12.3
Non-returnable bottle:	
16 oz. glass	12.02
16 oz. plastic (PET)[1]	11.54
16 oz. plastic (AN/S)[2]	11.57
Returnable glass bottle system with a trippage of 10	3.6

Source : Adapted from OECD 1978 : 72

[1] PET = Polyester (Polyethylene Terephthalate)
[2] AN/S = Acrylonitrile/Styrene

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*Therm = A unit of heat equal to 100,000 British Thermal Units (BTUs). A BTU is the heat required to raise the temperature of one pound of pure water 1° Fahrenheit.

AIR AND WATER

The materials flow model suggests that increased recycling should result in less environmental pollution. Overall, less air and water pollution results with the recycling of many common products such as paper, glass, and steel.

Both air and water, however, may not benefit from recycling. For instance, though paper made from paper stock rather than softwood generates relatively few gases, substantially more solids dissolved and suspended in water may result (Bower 1977; OECD 1979). In this case, consumer acceptance of paper with less brightness, or use of the paper in materials where brightness is not important, would decrease the amount of de-inking required and would improve the environmental benefits of recycling. Table 3 gives data on the contributions to air and water pollution by various types of beverage containers. The data suggest that overall environmental advantages begin with the five-trip bottle and are especially significant at higher trip rates, although waterborne wastes for the five-trip bottle exceed those for non-returnable containers. The data do not account for the relative toxicity and damage costs caused by each emission category (OECD 1979). Where recycling is not advantageous for both air and water, the types of contaminants and their effects on various components of the environment must be carefully considered, as with other environmental trade-offs.

Table 3. Summary of Air and Water Pollution from Beverage Container Systems (United States)

	Atmospheric Emissions (kg/1000 L)	Waterborne Wastes (kg/1000 L)	Total
Returnable Bottle, 19 Trip	8.5	3.3	11.8
Returnable Bottle, 10 Trip	11.3	4.2	15.5
Returnable Bottle, 5 Trip	24.0	8.3	32.3
Non-Returnable Bottle	31.3	6.8	38.1
Bimetallic Can	26.7	4.1	40.8
Aluminum Can	38.8	7.1	45.9
Plastic Bottle, Steel Closure	28.8	8.2	37.0

Source : Adapted from OECD 1978 : 59

The apparent advantages of recycling also depend on the manner in which technical and accounting matters are considered. For example, if the recycled fiber content of newsprint increases, the total amount of fiber per unit of paper may need to be increased in order to retain strength characteristics. The environmental gains achieved by recycling would then not be as large. Whether recycling makes sense may depend on whether the country involved is an importing or exporting country. If a country imports wood pulp, it may find that much of the environmental impact occurs in the pulp-manufacturing country. In such instances, there may be less impetus for recycling. (However, countries such as Holland and Japan that depend on imports of paper recycle substantial amounts). In pulp-producing countries, a sizeable percentage of the materials used in the manufacture of paper products (furnish) can come from residues generated in lumber and plywood manufacturing industries, raising the possibility that if the paper industry used recycled paper instead of the residue, wastes from manufacturing industries could be discharged to the environment (OECD 1979). Presumably, however, a higher utilization of recycled paper would displace virgin wood before it displaced residues, since pulpwood is a more costly furnish than wood residues.

The complex nature of the inter-relationship of energy use, water use, air and water effluents generated, and the costs associated with each element can be seen from an examination of Table 4.

As can be seen, waste paper that has not been de-inked needs the least energy, consumes the least water, generates the least biological oxygen demand (BOD) (though substantial suspended solids are generated), and exhibits the lowest cost of any material source. When waste paper is de-inked, much of the advantage of lower water pollution levels disappears, though both energy requirements and cost advantages are maintained over mechanical and chemical pulps. Perhaps the best overall comparison is obtained when total relative costs are compared. If Dutch florins are converted to an index of 85 florins = 100, then the relative advantages of the different material sources are clear. It also illustrates the increasing attractions of new forms of mechanical pulping where water resources are scarce.

Generally, recycling affects the environment less adversely than does the use of virgin materials. In those instances where recycling does create more air or water pollution than the use of virgin materials, research on new technologies, for example on better de-inking processes for waste paper, may enhance the attractiveness of recycling.

RAW MATERIALS

In addition to decreasing pollution, reducing materials flow by recycling will reduce raw materials depletion. The importance of this factor will vary depending on the abundance and sustainability of the resource. In the case of recycling glass, the need to conserve the raw material, silica, is negligible because it is abundant. However, for the case of rhodium, used in the manufacture of catalytic converters, the absolute limit on availability of the material makes recycling vital to the viability of the technology.

As raw materials become scarcer, costs rise, leading to more effort to find substitutes, while consumption will decline at a rate related to demand *elasticities*.

Since we live in a finite world, there must be a limit to growth. The extent to which we recycle can contribute to the lengthening of the time left until we run out of first the

Table 4. Energy and pollution comparison of several pulp manufacturing methods

Kind of pulp				Water Pollutants		Air Pollutants				Costs					Index
	Needed Energy	Needed Steam	Water	BOD[1]	SS[2]	SO_2	H_2S	Mercaptanen	Dust	Energy	Steam	Water	Water Cleaning	Total	
	(kWh)	(ton)	(ton)	(kg)		(kg)				(florins[3])					
Waste paper without de-inking	200	–	10–25	5	20–30	–	–	–	–	32	–	13	40	85	100
Waste paper with de-inking	400	1	38–150	8–40	20–50	–	–	–	–	64	20	75	40	199	234
Mechanical pulp	1,200	–	15–40	10	11–15	–	–	–	–	192	–	20	40	252	296
Chemical pulp	700[4]	3–10	100–200	20–50	10–50	20	13	3	80	32	200	100	50[5]	382	449

Source : OECD 1979: 83

Note : all values are related to 1 ton Ludro pulp.

[1] BOD – Biological Oxygen Demand

[2] SS – Suspended Solids

[3] Dutch florins

[4] If black liquor is incinerated the net needed energy will be about 200 KWh.

[5] Including control of incineration emissions.

scarcest of raw materials and ultimately the more abundant ones. Indeed, economists foresee an inevitable rise in the rate of recycling with increasing scarcity of raw materials or a rise in energy costs. As raw materials become scarcer, their price will rise, leading to a search for substitutes, including recycled materials.

The long-term future for recycling is therefore good. However, the transition period may be uncertain, with recurring shortages and gluts. Shortages will lead to high raw material prices and thus to a search for substitutes (including recycled material); this brings forth additional supplies, which drive prices down. Low prices lead to a shedding of capacity and a rebuilding toward a new shortage. The development of a recycling industry resilient enough to maintain an existence through these cycles of scarcity and surplus would help to reduce the spread between peaks and troughs and help to maintain the essential infrastructure and skills, thus enabling a more rapid response to fluctuations.

LITTER

Judged by responses to surveys, littering is a problem of public concern in Alberta (MIR 1981; Krahn 1983). The costs of collecting and disposing of litter are borne by all taxpayers regardless of whether or not they litter, and the costs are substantial. For example, the 2.2 billion beverage containers discarded in the United States in 1969 would have cost $41.8 to $85.8 million to collect. Those containers not collected and remaining as litter impose non-monetary nuisance costs (OECD 1978). The costs of collecting a container discarded as litter exceed those for a container dropped in a curbside collection bin by close to 20 times (Goddard 1975). Reduced littering and resultant savings in collection and disposal costs are attractive features of recycling programs.

The reduction in litter and waste management costs depends on how extensive recycling programs are. To illustrate this point, consider the recycling of beverage containers, which is often enhanced by beverage container deposit legislation (BCDL). The effectiveness of BCDL as a litter-control strategy depends upon the contribution of beverage containers to the litter problem and the effectiveness of a deposit-refund system in reducing the contribution. While BCDL has been very effective in reducing beverage container litter, its effect on the litter stream and on the costs of litter pick-up have been less spectacular though still significant.

Surveys of highway litter in the state of Vermont estimated that the BCDL program there resulted in a 76 percent reduction in beverage container litter, a 35 percent reduction in total litter (measured by volume), and a 31 percent decrease in the cost of litter pick-up. Similar successes were estimated in Oregon (OTA 1979). Data on the effects of the deposit-refund system in Alberta are not available (Hare 1983), but based on the amount of glass recycled, one can reasonably conclude that significant reductions in litter and litter pick-up costs also have resulted in Alberta. Other evaluations of the efficiency of recycling programs in reducing the impact of litter are less optimistic (for example, see OECD 1978), but this is not surprising in view of the subjective assessments necessitated by difficulties in measuring litter and the costs of pick-up.

Recycling has the potential to reduce litter and consequent waste management costs. From the recycling perspective, the most attractive component of litter is the beverage container. Depending upon beverage containers' contribution to the total litter volume and their persistence (biodegradability), recycling them will have a moderate to substantial effect on the perception of littering. However, unless legislative and economic incentives to recycle are applied to all goods, the effectiveness of recycling as a litter control strategy depends upon society's willingness to transfer its non-littering attitudes to other, non-targeted items. For example, a successful litter control strategy for beverage containers made possible by a recycling program would also reduce the number of other items that are littered, such as candy wrappers and cigarette packages.

REDUCTION IN SOLID WASTE GENERATION

Reduction in materials flow would reduce the amount of solid waste needing disposal. The environmental benefits of less solid waste would be significant, in terms of improved aesthetics of surroundings, preservation of land for other productive activities, and avoidance of contamination in the vicinity of landfills that results in continuing and heavy costs for clean up. Reduced costs for the collection and disposal of waste can also result from recycling.

The total costs of collection and disposal vary from one location to the next, but collection costs are usually much greater than disposal costs (OECD 1978); some data relevant to Alberta are found later in this report. Savings to a municipality depend upon the reductions in collection or disposal costs made possible by recycling. Where fixed costs are prominent, collection and disposal cost savings will not be proportionate to reductions in waste load due to recycling (Environmental Resources Ltd. 1978; OECD 1978).

The amount of money saved and the distribution of savings between collection and disposal varies with collection systems. For example, where a municipality collects refuse and disposes of it, the savings due to recycling mainly result from reduced disposal costs. Where, for example, a charity operates a separate recycling collection scheme, the municipality may save on collection costs. Reductions in both collection and disposal will occur where private contractors are hired on a per-tonne basis, but if the refuse is not weighed and the contractor is paid on a household basis, collection cost savings may not fully reflect decreased refuse loads (OECD 1979). Savings in disposal costs due to recycling are more certain than savings in collection costs, but are sensitive to the type of disposal option used. In general, if higher cost disposal systems such as incineration (as opposed to landfill) are being used, or a remote as opposed to a nearby landfill, reductions in waste load due to recycling become more economically attractive (OECD 1979).

MORE RECYCLING?

Overall, the environmental benefits attributable to recycling are substantial. For many commodities recycling is already a proven and acceptable method of supply. But what about the 50 percent of the aluminum cans in the United States (*Resource Recycling* 1985) or the 80 percent of paper in Canada (Pilsworth 1984a) that are not recycled? Obviously, large amounts of even commonly recycled products are being missed despite the environmental benefits of recycling. Increasing the economic attractiveness of recycling is one way of increasing the environmental benefits to be gained from recycling. Measures to encourage recycling that may be initiated by government or private industry are discussed in the following section of the report.

4. OBSTACLES TO INCREASED RECYCLING AND POLICY ALTERNATIVES TO OVERCOME THEM

IMPLEMENTING POLICIES TO ENCOURAGE RECYCLING

Considering the environmental and economic benefits to be derived from recycling, there is room for more recycling to occur. The key seems to lie in improving the economic attractiveness of recycling. Most of the following material is devoted to describing several economic measures that can be used to increase recycling activity.

Ideally, before measures to increase recycling are implemented, their efficiency should be evaluated. Efficient policies are ones incurring the least costs, both direct and indirect, for obtaining a level of benefits (Goddard 1975). Only after examining a whole package of different costs (capital, energy and environmental, social, and administrative) associated with implementation of a measure, and those associated with the failure to do so, can appropriate decisions about the various methods to encourage recycling be made. In some cases it may not be necessary to prove that the approach can stand alone economically, rather that the approach results in lower costs than other options, including those now in place (OECD 1979).

Predictions about the various impacts of measures to increase recycling cannot be made with the same degree of accuracy or precision characteristic of the physical sciences. At this point, decisions about policies to encourage recycling often are made using principles, common sense, and intuition as guides, as well as knowledge gained through the application of economic policies in other areas of the economy. These, along with the best hard information available at the time of decision, are the best criteria that can be used to decide which policies to use.

The issue of incinerating municipal solid wastes begins to illustrate the difficult nature of the economic, ecological, and social questions involved in decisions about policies or approaches to encourage recycling. Many of these questions are described at greater length in another report, *The Use of Municipal Waste as Fuel*, available as reference material for the recycling hearings.

By decreasing the volume of waste that is landfilled, incineration can extend landfill lifetimes. Thus incineration offers authorities some relief from the costs and political troubles associated with finding suitable disposal sites every 15 years or so. Incineration also offers the prospect of avoiding some of the contamination problems associated with landfills that have become so well known within recent times. The prospect of generating steam heat or electricity from wastes that would otherwise not realize any value also enhances the attractiveness of incineration. Based on advantages such as these, incineration seems to be an appropriate way to recycle.

However, getting rid of what one does not want is not always the same as having what one does want. Incineration has some environmental problems of its own, such as water and air pollution. Incineration is generally a more costly method of waste disposal than landfilling. Furthermore, in some cases incineration may require "flow control" (monopoly on the flow of waste materials) to operate efficiently, which may impinge upon the recycling of other incinerables such as paper (Chandler 1983). Are the negative characteristics of incineration sufficiently offset by its attractions to conclude that it is preferable to landfilling, or are both outmoded as methods of waste disposal?

In a similar vein, it is possible to draw conclusions about the advisability of using buffer stocks or bans, deposit refunds or virgin materials taxes as measures to encourage recycling. The information that follows describes these and other methods to encourage recycling, and presents various advantages and disadvantages that relate to their efficiency. In many cases the thoughts presented are matters of opinion, with which the reader may agree or disagree.

POLICIES RELATING TO SUPPLY OF RECYCLED MATERIALS

Stabilizing Market Fluctuations

The prices of secondary materials fluctuate widely. The uncertain environment created by the fluctuations works against recycling. For risk-averse natural resource owners, uncertain price expectations for their product would be an incentive to accelerate their rate of production (Anderson 1977); because of the interest that can be earned, money held today is worth more than money with the same face value held sometime in the future. Dealers in scrap materials are thought to prefer to hold smaller inventories under uncertain price conditions. This would tend to result in higher prices for scrap, and producers are likely to incorporate smaller amounts of reclaimed and recycled materials into manufactured goods (Butlin 1977).

The price for primary materials also fluctuates, which necessitates adjustments on the part of suppliers and producers. But greater changes seem to be characteristic of recycled materials. These greater changes could be the result of many circumstances, including:

1) Certain types of secondary materials are used in the production of goods having restricted usage, for example, roofing felt or cellulose insulation used in housing construction. When the housing construction industry slumps, the demand for and price of the component recycled materials fall. Flat demand for waste paper from the building materials industry was evident in the United States in the beginning of 1985 (*Resource Recycling* 1985).

2) Different structures of primary and recycling industries, with the former tending to be dominated by a few companies and the latter by many small ones. The

vertical integration possible in larger companies helps to stabilize the price paid for inputs (Bower 1977). One local example of vertical integration in the recycling business is Belkin Paper Stock Limited, located in Calgary, which supplies various grades of paper to Belkin Packaging Limited, a manufacturer of cardboard, linerboard, and other paper products, located in Burnaby, British Columbia.

Preventing those involved in the recycling business from being subjected to the full impact of large changes in the price of secondary materials would help promote recycling. In the next few pages, three types of stabilization schemes are discussed: buffer stocks and buffer funds, long-term contracts and guaranteed prices, and futures markets. The discussions are out of necessity concise, but fuller discussions of these and other methods of encouraging recycling are found in the references listed at the end of the report.

Buffer Stocks

Proposals to stabilize market fluctuations, at least in the waste paper markets, have concentrated on buffer stock schemes, where paper is stored at times of low demand (or excess supply) and released at times of high demand (or low supply).

There are two main problems associated with buffer stocks: setting the initial "optimum" price range, and keeping prices within the optimum range without the use of fiscal measures. One undesirable outcome of buffer stocks is that the suppliers' incomes could actually be less (though more stable) under the controlled market than under the free market. This would be unattractive to the recycler who was attracted to the business by the ability to gamble on market fluctuations, but it would be more attractive to the customer and the risk-averse recycler.

The acceptability of buffer stocks to private merchants would be influenced by how the stock-holding agency was operated. For example, if the agency intended to hold all grades of waste, its operations would compete directly with the private recycler. If the stock-holding agency concentrated on low-grade stocks, which fluctuate the most in price and are typically abandoned by recyclers during low periods of the business cycle, there may be greater complementarity.

If one of the aims of a buffer-stock scheme were to stabilize domestic prices for the reclaimed material, some mechanism to insulate the domestic market from internationally determined prices might be required. Also, since there is the possibility that the scheme would attract substantial imports from other countries (or provinces), some form of import control may be necessary (OECD 1979). Recently, for example, demand for virgin and secondary non-ferrous metals in the United States has been hurt by "the continuing flood of imports" (*Resource Recycling* 1985: 32). At this time Canadian recyclers generally do not think that import tariffs are desirable as a means of stimulating recycling, although there are strong regional differences of opinion (Taylor 1982).

Buffer stocks do not appear to be a commercially profitable venture. A simulation study showed that a buffer-stock operation for paper in the United Kingdom from 1960 to 1974 would have run at a loss of £3.4 per tonne purchased and sold. A simulation study of paper recycling in Belgium also showed that, based only on direct revenues and expenditures, the buffer-stock venture was not profitable (OECD 1979).

Buffer stocks are unlikely to increase prices to suppliers, however, because paper supply has low price elasticity. What seems to be more critical is keeping a collection infrastructure in existence. Voluntary organizations involved in paper collection in particular will tend to take price fluctuations in their stride and continue collection through high or low prices (low price elasticity). However, the complete choking off of an outlet leaves them with a basement or clubhouse full of waste paper, a planned paper drive in tatters, and a feeling of futility and wasted effort. A few experiences like this are sufficient to discourage the most dedicated from including recycling in their volunteer efforts.

Buffer-stock schemes are therefore not attractive from a market viewpoint; they generally lose money, and prices set too high or inappropriately could draw in extra-provincial supplies in periods of general surplus. However, they are attractive for keeping a complex social infrastructure in existence during periods when markets would otherwise dry up completely.

Buffer stock schemes, however, are generally more appealing than buffer funds, which operate by withholding some of the material suppliers' earnings in periods of high demand and using the withheld monies to support suppliers' incomes in periods of low demand. Here too suppliers can suffer losses compared with free-market situations (OECD 1979), and under certain sets of conditions the market situation can be destabilized rather than stabilized. Uncertainties about elasticities of supply, upon which the success or failure of buffer funds depends, suggest that the use of buffer funds is not commercially sound (Butlin 1977).

Long-Term Contracts and Guaranteed Prices

The use of long-term contracts is another method of stabilizing prices in the secondary materials market. With the use of long-term contracts, both the reclaimer and user agree to a price and organize their operations over a period of time during which prevailing market prices are ignored (Bidwell 1977). Long-term contracts are fairly common for *prompt scrap*. Where these contracts exist, the degree of business stability that follows for a recycler would depend upon the amount of *old scrap* surfacing in the market. Long-term contracts for old scrap are not common, for with these contracts, scrap dealers encounter heavy transaction costs (Butlin 1977).

Long-term contracts may offer both maximum and minimum guaranteed prices or just a minimum guaranteed price. Guaranteed price systems for paper have demonstrated problems including:

1) the producer may agree to a minimum price, but may not necessarily agree to take any amount of recycled material at that price,

2) where minimum prices are associated with a requirement to take all quantities offered at that price, excessive levels of stock can be quickly reached in times of surplus, and

3) if quantities accepted are limited, suppliers can be discouraged from entering the market (OECD 1979).

Some of these problems are matters of negotiation, so that the successes or failures of suppliers and producers stem in part from their abilities as negotiators. However, in the absence of a buffer-stock scheme (indeed, long-term contracts and guaranteed prices are essentially privately negotiated buffer-stock schemes, usually restricted to the more desirable scrap supplies), long-term contracts and guaranteed prices would only be applicable to a small segment of the market.

Futures Markets for Recyclable Materials

A futures contract is an agreement calling for the delivery of a given quantity and quality of commodity at a set future date; the contract itself also can be bought and sold. Allowing secondary materials producers the opportunity to hedge against future price changes by allowing futures trading in secondary materials would be another way of decreasing uncertainty in the industry (Butlin 1977). For example, a merchant holding and accumulating stocks of secondary material for eventual sale may think that prices for the material will rise in the near future. But the merchant also recognizes that he could be wrong, so he sells futures contracts. If prices do in fact drop, the merchant may lose money on the actual cash transactions, but by buying back his contracts at the lower price the merchant can cover some of the losses associated with the cash transactions, thus tending to stabilize income (OECD 1979).

A futures market would also reduce uncertainty because of enhanced information flow. The price of futures contracts is set by all the information the market possesses about what is expected to happen. This dissemination of information ensures that everyone is better informed, thus reducing errors in buying and selling. By reducing uncertainty, the futures market should allow suppliers to react more readily and confidently to price changes, thus helping to reduce price fluctuations (OECD 1979).

Possible problems of a futures market include heightened speculative activity that could destabilize the market, and the difficulty of ensuring that grades of secondary materials are accurately specified in the contract. Also, futures markets operate with the buyers and sellers not knowing each other, which is uncharacteristic of the recycling trade (OECD 1979).

Ban on Problem Products

Bans on problem products are popular and frequently cited as a way of reducing the waste load and littering because the results seem obvious, and because the legislation is relatively easy to enforce (OECD 1978). The cost is basically limited to that of legislating the ban and, initially, to some small level of enforcement. Although the legislation might be enacted at, for example, the provincial level, enforcement could be local so that the high cost of large bureaucratic structures might be avoided. Bans on certain products, for example, non-returnable containers, probably would result in cost savings to consumers because of savings in materials, and the cost savings would favor low-income groups, as would the benefits of increased scavenging. The price effect of bans, however, is not clear. For instance, Hall and Ackoff (1972) argue that the price of beverages would have to be increased in order to cover increased handling costs.

Perhaps the main complaint against bans is that they ignore consumer preferences. For example, a ban on non-returnable beverage containers would decrease the welfare of those preferring and paying for the convenience of single-use containers and properly depositing them in the waste stream. Decreases in employment in manufacturing industries (for example, beverage containers) could be offset by increases in recycling components of the economy (Goddard 1975).

Direct Charge for Solid Waste Disposal

The costs of solid waste disposal and collection are substantial. In the United States in 1973, based on estimated costs of $26 per ton, the costs of collection and disposal of packaging items alone were $1.2 billion, not including litter (Bingham 1977). For the City of Edmonton, the 1984 net expenditures for solid waste disposal were $9.7 million, based on per-tonne costs for collection, the transfer stations, and landfills of $41.33, $12.02, and $1.94 respectively (Edmonton Water and Sanitation 1985). For Calgary, the 1984 net expenditure was $8.6 million, based on per-tonne collection costs of $36.53 and per-tonne disposal costs of $4.36 (City of Calgary Engineering Department 1985). Even at this level of expenditure, the disposal costs may not be based on a long-term outlook, that is, one which accounts for environmental concerns. There is a growing body of experience with long-term environmental problems originating with waste disposal in landfills.

Typically collection and disposal costs are paid out of general revenue, and, even when paid directly by households, are paid at a flat rate, that is, in fixed monthly amounts not varying with the amount of solid waste generated. Thus, notably in larger centers where many taxpayers share the costs of waste management, the cost to the person generating extraordinary amounts of waste is negligible while those people who exercise care to minimize the wastes they generate pass on the gain to everyone else.

When discarded products enter the waste stream and are not costed on the amount discarded, excessive amounts of certain materials will flow through the economy. For example, excessive amounts of packaging will be consumed. Development of resource-conserving technologies is slower when solid waste management services are not priced on a volume and cost-of-disposal basis, and already existing conservation technologies are likely to be under-utilized (Smith 1977).

Charging in direct proportion to the amount of waste generated would appear to be desirable from the perspective of resource conservation, cost equity, and as a stimulus to other recycling approaches. This policy tool is precise and equitable; costs are not created for the consumer "over and above those needed to manage the wastes that the consumer chooses to generate" (Goddard 1975: 174). Pricing also offers the benefit of minimizing government interference with choice; individuals can choose and pay for their own waste generation practices (Goddard 1975). In jurisdictions where either private waste disposal firms or municipal fee-for-service approaches are adopted, these benefits should already be occurring.

Pricing can lower the cost of recycling by assisting in the separation of waste materials at the point of origin, otherwise known as "source separation." The lack of methods of cheaply accumulating unmixed material is an obstacle to further recycling, and collection of sorted wastes from households is one way of accumulating unmixed materials. Successful source-separation schemes depend first upon inducing householders to separate materials so that they are free from contaminants and, second, on high participation rates. The costs of refuse collection often increase with source separation schemes (assuming the waste loads do not decrease), but sufficient savings can occur to make source separation cost effective, due to a reduction in sorting and disposal costs (OECD 1978, 1979; Goddard 1975). Two countries that operate successful household recycling campaigns, Sweden and Germany, also operate systems of directly charging for solid waste (OECD 1978), which suggests that appropriate pricing for waste disposal may be important to the success of recycling.

Charging for the incremental use of municipal waste collection and disposal services does have drawbacks. Depending upon how the user charge is calculated, other means designed to avoid the charge rather than solve the problem might surface. For example, if the charge was based on volume of waste, householders may invest in energy-consuming trash compactors or there may be attempts to avoid the tax altogether by illegal littering or dumping, although the littering can be offset with help from deposits and enforcement (OECD 1981; Goddard 1975). Pricing is also felt to be *regressive* with respect to income, but paying for waste disposal with property taxes is more regressive, for it does not allow low-income individuals to reduce their tax burden by reducing the waste they generate (Goddard 1975).

On balance, levying charges for solid waste disposal that are proportionate to the amount of waste generated would appear to be an effective way of increasing the supply of materials for recycling. To be fully effective, the increased supply would have to be matched by increased demand for recycled materials, a subject discussed in the next section.

POLICIES RELATING TO DEMAND FOR RECYCLED MATERIALS

Introduction

Working on the supply of secondary materials will do little to encourage recycling for most materials unless there is an increase in demand for the recycled product. Taking action solely to encourage supply is likely to depress the market and may result in some recycled materials not being used at all. (Working solely on demand could create shortages and high prices, improving the competitive position of virgin materials). Measures to simultaneously increase supply and demand are necessary for successful recycling, although demand should be emphasized, since producers and handlers would be motivated to find ways to increase supply (Bidwell 1977; Environmental Resources Ltd. 1978).

For the business community, profit is the strongest motivator. One of the major difficulties on the supply side, in addition to fluctuations in the market, is that waste materials do not provide sufficient return over collection and other costs. "Smoothing the fluctuations may do little to encourage recycling if the trend price is not raised" (OECD 1979: 87). There are, of course, many recycled materials for which demand is high and reasonably steady. The following comments apply principally to low-grade scrap, which is relatively costly to reuse, collect, or purify. The low-grade scrap is the material on the margin, in demand when supplies are tight and subject to wild fluctuations in price.

Virgin Materials Tax

Increases in the relative price of virgin raw materials are thought to be likely to encourage greater use of reclaimed materials and to encourage the removal of some obstacles to recovery. Taxes levied on the use of materials having a high content of targeted virgin materials or materials that cause extra disposal problems would be one way of increasing the relative price of virgin materials (Environmental Resources Ltd. 1978).

There may be difficulties in establishing the correct price level to minimize distortion or other social costs. Some studies have suggested that the demand and supply for waste paper are price inelastic, and, if correct, this means "that only very substantial virgin materials taxes could lead to significant changes in the use of waste paper" (OECD 1979: 86). There is also a risk of substitution of other virgin materials rather than secondary materials if the cost of a virgin material is increased by tax. The use of virgin materials taxes would seem to be most useful where the risk of substitution is small or where considerable social costs are associated with the use of virgin material (for example, if the production of virgin material resulted in high pollution or waste disposal costs) (Environmental Resources Ltd. 1978).

Depletion Allowances, Capital Cost Allowances, and Severance Taxes

There is a bias towards the use of virgin materials through the use of fiscal incentives such as *depletion allowances* and *capital gains provisions.* Some evidence from the United States shows that depletion allowances and capital gain treatments cause over-investment in development and extraction, even to the point where a dollar invested could return less than a dollar and the company would operate at a profit (Goddard 1975). Assuming that final products are of equal quality whether constructed of virgin or secondary materials (which is not always true), it is thought that the greater danger from tax deductions provided by depletion allowances and capital gains provisions lies not so much in reduction of the product price to the final consumer (with consequent increases in demand) as in the acquisition of plant and equipment specialized to virgin material by the manufacturer, and in the acquisition and development of new sources of virgin materials. The tax advantages are also considered to stimulate the development of new technologies to use virgin materials in order to gain further cost reductions (Goddard 1975).

Adamson (1984) has commented on the role of exploration expense deductibility in Canada as a disincentive to recycling; up to 100 percent of Canadian exploration expenses can be written off against any source of income by individuals or corporations not primarily engaged in the exploration or production of petroleum, natural gas, or minerals. Also, the accelerated capital cost allowance (ACCA) assists environmental enhancement by helping industry to purchase pollution control equipment, but does not act as an incentive for investment in recycling and reduction equipment.

There are three possible approaches to eliminating the biases towards virgin materials industries created by the above tax provisions. One possible solution would be to apply similar tax provisions to secondary materials industries. This would "eliminate the bias relative to one another, but would increase it between the goods-producing sector of the economy and the service sectors" (Goddard 1975: 164), though the economy would probably be moved to a higher level of well-being because of cost savings in disposal and because of greater conservation. A second approach would be to remove taxation subsidies for the virgin materials industries and apply them only to secondary materials industries. This should raise the long-run demand for secondary materials and would expand supply (Goddard 1975). However, the third approach, removal of depletion allowances and capital gains privileges alone, without application to secondary materials industries, may be sufficient to increase the use of secondary materials (Goddard 1975; Anderson 1977). If so, it would appear to be an efficient way to eliminate the bias towards virgin materials industries.

In at least one case, "equal" tax treatment for the primary and secondary materials industries is argued to have a detrimental effect on recycling. Under Canada's Excise Tax Act, a tax is levied on the sale or consumption of goods manufactured or produced in the country. Some recycled goods, such as re-refined oil, are twice subject to excise taxes, at the time they are produced from a raw resource, and at the time they are reconsumed as a recycled good. With the double tax on re-refined oil, the price is comparable to virgin crude oil, so there is little incentive for the consumer to purchase the recycled product (Adamson 1984).

Where active discouragement of the use of primary materials is the goal, devices such as *royalty payments* and *severance taxes* can be used (Anderson 1977). Severance taxes slow down the rate of depletion and increase the pay-off to substitutes because the rate of taxation increases as more of the resource is extracted. Page (1977) asserts that severance taxes possibly would be nearly costless to the present population, because of the slack provided by existing inefficiencies in virgin materials industries. The low cost of severance taxes might make them an attractive method of encouraging recycling.

Product Charge Tax

Another way of encouraging less wasteful use of raw materials would be to levy charges on products, often at the point of manufacture, at a level that would cover the collection and disposal costs for the used good or its packaging. The charge could include corrections for other market distortions thought to bias against recycled materials and could include external damage costs to the environment (OECD 1979). Further, working in tandem with a product charge on virgin products, an exemption from the charge of goods manufactured from recycled materials could encourage recycling. The product charge revenues could go to local municipalities since they bear the costs of disposal, and this money could be used to provide better services to the community, or local taxes or rates could be decreased (OECD 1978, 1979).

Levying a product charge would initially raise the cost of goods, but through a reduction in waste disposal costs (minus the costs of administering the policy) or through the provision of a less polluted environment, consumers potentially can gain back the increased costs for packaged products that would be charged to them. For the United States, it was estimated that the amount saved due to reduction in solid waste generation would be enough to offset the consumers' loss in real income (Bingham 1977).

Equity considerations might be the major drawback associated with product charge taxes. The product charges are regressive (Bingham 1977; OECD 1981; Bohm 1981). Although higher income families experience greater dollar losses than lower income families, the tax tends to impact lower income families more severely. Another shortcoming is that product charges do not differentiate between good and bad behavior, such as littering and not littering, and so are not as equitable a treatment as are deposit-refund systems (Bohm 1981), which are discussed next.

Deposit-Refund Systems

Deposit-refund systems can be used for a variety of purposes. They can be used to discourage activities in production or consumption, to encourage reuse as opposed to use as a secondary material or as a byproduct, to encourage proper disposal of certain materials, and to provide funds to finance litter collection and disposal (Goddard 1975; Environmental Resources Ltd. 1978). Although most often thought of in terms of returnable beverage containers, deposit-refund systems are applicable to many other items including automobiles, household appliances, plastics, waste lubricating oils, and others. Deposits can be applied as limited deposits (only applied to one or a few items), or as generalized material deposits, that is, applied on all materials moving through the markets at a level reflecting social damages from the most harmful form of disposal (Goddard 1975).

Each type of deposit has advantages and disadvantages, with limited deposits generally being the preferable of the two. The direct costs of producing the desired effect are likely to be much lower, and the degree and costs of administrative centralization are probably less for limited deposits than for generalized material deposits (Goddard 1975). Limited deposits are fairly neutral, while exemptions would be required to eliminate the non-neutrality created by the use of generalized material deposits. Limited deposits "create no generalized income and employment effects if they are not large relative to both personal income and product price" (Goddard 1975: 171), whereas general material deposits could result in substantial employment and income effects, especially if the goal is to increase the proportion of materials-conserving activities in the GNP (Goddard 1975). Phasing in of mandatory deposits would reduce employment dislocations (OECD 1978). In cases where there is less than a maximum return rate resulting from the use of deposit refunds, the return rate may differ among income groups. If the return rate were highest among households with a low opportunity cost for time (that is, low-income households), a deposit-refund system would have a "progressive" effect (Bohm 1981: 7-8).

Mandatory deposits could conflict with other recycling efforts. Resultant changes in the level and composition of the solid waste stream could affect the viability of resource recovery operations. The decline in revenue potential resulting from the separation from the waste stream of materials on which deposits have been applied could mean that recovering the remaining materials would not be profitable for the company recovering the materials. Mandatory deposit refunds, however, are not likely to affect decisions to install resource recovery systems except in very marginal economic circumstances. In the case of one steam recovery plant, it was thought that deposits would raise the profitability of the plant because the combustible portion of the waste stream would be increased (OECD 1978). Thus, the conflict between mandatory deposits and other recycling efforts does not appear to be very serious.

Deposit refunds, especially limited deposits, can replace pure tax or subsidy schemes as an alternative to regulation and avoid some of the undesirable distributional and budgetary effects. In many applications, deposit-refund systems may provide stronger or better focused incentives and involve less policy cost than the alternatives. In some cases, deposit refunds may be the only possible solution; for example, because of detection problems, neither a tax nor a ban on improper disposal, or increased enforcement funding, is likely to be effective in reducing the number of people throwing away cadmium batteries, but a deposit refund conceivably could be effective (Bohm 1981; Goddard 1975). Deposit refunds also offer the advantage of informing buyers "about different disposal options and their costs at the time of purchase" (Bohm 1981: 8). The flexibility, effectiveness, and potentially low costs of deposit-refund systems make them an attractive option to increase recycling.

Direct Subsidies

There are many different ways that subsidies may be used to encourage recycling and conservation, including operating and capital subsidies for recycling firms, interest-rate subsidies on borrowed capital, transportation subsidies for recycled materials, and subsidies for research and development in reclamation technology (Butlin 1977; Goddard 1975).

One fairly new type of subsidy is the "diversion credit," whereby regional or municipal governments pay non-profit or other recycling organizations all or a portion of the savings in collection and disposal costs made possible by the recycling program (*Ontario Recycling Update* 1985). Both government and the recycling industry appear to benefit from the diversion credits. One key to their proper use seems to be the successful tabulation of all costs related to disposal, which helps to make the cost savings from recycling clearer.

Subsidies should not be used to "bribe" those responsible for environmental pollution to reduce their effluent streams. A subsidy so applied would give a company (or individual) an incentive to increase its effluent stream or would attract more polluting firms to the jurisdiction, thus increasing the size of the subsidy needed (Goddard 1975).

Subsidies, if properly conceived, can take effect immediately, do not require central administration, and employ self-interest to ensure compliance. Subsidies, however, appear to offer fewer advantages than disadvantages.

One disadvantage of subsidies is that they are costly, with the costs for operating subsidies generally exceeding those for capital subsidies. Characteristics that tend to make subsidies fairly expensive instruments include:

1) they lessen incentives to be efficient, and to be aware of lower cost alternatives, especially operating subsidies,

2) much information is needed to ensure that the subsidy is necessary and that the desired response is obtained, and the collection of this information is labor-intensive, and

3) the subsidies are often paid out of taxes. Unless the tax is a benefit-oriented one, there may be an additional loss of consumer welfare in excess of that needed to achieve the objective. Since the society as a whole is likely to benefit from

more recycling and conservation, broad-based taxes like personal income taxes could be chosen to raise the subsidy revenues. Doing so, however, could reduce incentives for individual taxpayers (Goddard 1975); alternatively, there could be more incentive for underground economies to develop.

Policing may also contribute to the cost. For example, primary manufacturing operations are the source of prompt scrap and often they must pay for disposal services they use. The presence of a subsidy only on post-consumer scrap could create an incentive for scrap dealers to disguise industrial scrap as post-consumer scrap. In addition to cost, subsidies to recyclers may be undesirable because they would further the existing distortions between the price of natural resource based materials and other inputs, so that too much of both virgin and recycled materials would be used relative to the use of capital and labor. Subsidies to recyclers might reduce demand for primary materials, but would not correct the difference between private and social costs (externalities) in primary production (Anderson 1977). Also the history of perverse effects created by subsidies such as price-support programs in agriculture might cause reasonable anxiety about using subsidies to promote recycling.

Anderson (1977) felt that the maximum subsidy for recycling that could be justified on the basis of efficiency would be equal in amount to the full social costs of post-consumer waste disposal. However, the logical (least-cost) method to resolve the problem would seem to be to attack directly those factors that inhibit the market forces creating the desired result, instead of acting indirectly through a system of new subsidies (Goddard 1975).

Increasing Consumer Acceptance

One of the market obstacles to recycling is a belief that recycled materials are inferior to virgin materials. For some products the attitude may be based and justified on technical grounds, for which research and development could be the solution. For other products the attitude may be just a problem of perception. Mistaken perceptions may be built into specifications, so that secondary materials are excluded even though they could perform technically as well as virgin materials, or performance specifications may be overly stringent. Policies aiming to overcome such market obstacles should emphasize seeking outlets for lower grade wastes, since high-grade wastes are likely to be in much greater demand (OECD 1979).

One way to overcome such obstacles is to legislate against discrimination in the use of recycled materials that satisfy regulations and standards (Bidwell 1977). However, the commercial implications of such policies must be considered. For instance, if the recycled product were to have a small market, there is a greater likelihood that it would have to be manufactured in limited runs, which could raise the costs and prices. Legislating the use of recycled materials can be especially harmful to the economy or to certain businesses if competing countries or jurisdictions do not follow suit, unless the product incorporating recycled material can secure a significant price advantage (OECD 1979).

Rather than trying to increase consumer acceptance of recycled products by changing the incentives and signals that consumers and producers react to, one can operate directly on attitudes, for example, through information campaigns to promote the awareness of social benefits and costs associated with different materials use and disposal practices (Goddard 1975). Typically such campaigns do not try to measure the impacts of the program, and it is difficult to evaluate their effectiveness, but they are relatively low-cost methods. In view of the general lack of sound data on public information campaigns, the larger issue may be an ethical one: "should citizens' income be reduced through taxation in order to finance public authorities' efforts to change their attitudes and preferences?" (Goddard 1975 : 176), though this is common current practice.

Technical Constraints and Design Considerations

The recycling of materials may be limited by technical difficulties in separating and recovering mixed or multi-material products (Bidwell 1977; Bower 1977; Taylor 1982). The problem is one of either the post-consumer material being unsuitable for certain forms of processing, or the lack of technology to economically recover and decontaminate the waste into a form suitable for reuse (Environmental Resources Ltd. 1978). Paper recycling provides an example of the cost associated with decontamination. Hot-melt adhesives used in packaging and publishing, pressure-sensitive adhesives such as tapes, and materials used in newspaper bundling are among the contaminants commonly associated with paper. Up to 50 percent of hot-melt adhesives could be removed by in-mill cleaning, but the cost would range from $2 to $6 per ton, a significant fraction of the price of waste paper (OECD 1979). Plastic-coated materials and steel beverage containers with aluminum tops are other common examples of materials that hinder recycling because of materials mixing (Goddard 1975).

Research into and development of ways of recovering, decontaminating, and reusing post-consumer wastes, especially at low throughputs, would help recycling efforts. Other useful areas for research and development include new production techniques, new products and marketing potentials, and changes in requirements for products (Wolbeck 1977). In many instances, measures to improve waste management should start at the product design stage; for example, recyclable manufactured products such as beer bottles could be standardized, and products could be designed to incorporate fewer mixtures or make materials easier to separate (Bidwell 1977; Environmental Resources Ltd. 1978).

The designing of automobiles to facilitate recovery is an area worthy of attention. Late-model cars contain far greater amounts of non-ferrous materials such as aluminum, zinc, and plastics than their predecessors. Such mixtures increase the costs of processing used car hulks (Bower 1977, 1975). In this particular case, the goal of energy conservation (in terms of kilometres per litre of fuel) has not been accomplished with recycling in mind. From an environmental point of view, research into ways to allow car designs to meet both goals would be desirable.

Another design approach that could be followed to conserve resources, decrease environmental impacts, and curtail solid waste management costs is product life extension. Increasing the physical durability of products would reduce the discard rate and the solid waste load. Conn (1977 : 128) noted that the potential for product life extension as a method of waste reduction is largely unexplored, but provided one hypothetical example of resource savings associated with extending the life of cars:

> *If all of those sold in 1980 were to last for twelve years (instead of about ten as at present in the United States), then by 1990 (assuming a steady state situation), new car sales would be expected to decrease by about 20 percent from a predicted level of about 14,300,000 units to 11,500,000 units. Annual resource/waste savings throughout all phases of the automobile life cycle would amount to about 6,700,000 tons, composed of 5,500,000 tons of steel, 151,000 tons of aluminum, and 142,000 tons of zinc.*

Such extensions in useful product life appear to be relatively inexpensive. One study conducted in Germany concluded that to double the life expectancy of a car by using higher quality materials would increase its cost by about 30 percent (Conn 1977).

It is assumed that once consumers are exposed to design alterations and informed of their attractions, they will demand more recyclability, a greater recycled content, and greater durability from manufactured goods (Goddard 1975). But before design changes are incorporated, it is necessary to give detailed consideration to the type of materials that would be substituted, industrial dislocations (especially if measures were brought in too quickly), and other social costs (Environmental Resources Ltd. 1978). In addition, there are several variables over which consumers have control (for example, their decision to repair or discard items) and over which manufacturers have control (the availability of spare parts) that should be appreciated before proceeding with efforts to extend product lifetimes. Even minor increases in cost may put the prices of more durable products out of reach of many consumers' pocket-books. Failure to recognize such variables could mean that policy-makers' efforts would be misdirected (Conn 1977) and unsuccessful in reaching environmental goals, or would reach one goal at the cost of sacrificing another.

Procurement Policies

Governments, as large consumers of many goods, could stimulate demand for recycled products by requiring that certain materials purchased by public authorities incorporate a certain percentage of secondary material. Though government procurement policies are often thought of in terms of paper, the policies potentially have much wider application, for example, using retreaded tires and recycled oil for government vehicles. Governments have a fairly constant and often large-scale demand for products, which should assure that the demand for recycled materials would rise (OECD 1979). Provided the government were to prepare suitable specifications and the changes were gradually incorporated to allow suppliers time to change their processes, recycling would be increased with a minimum of dislocation (Environmental Resources Ltd. 1978). Canadian recyclers generally agree that the failure of governments to purchase more recycled products is a barrier to recycling. Considering the present status of recycling in Canada, a provincial government having a procurement policy for recycled materials probably would have to purchase from only a few suppliers, often in different provinces (Taylor 1982). Is the goal of recycling important enough that the Alberta Government should purchase some recycled products from out-of-province?

A good example set by government might also stimulate others to use more recycled products (OECD 1979; Environmental Resources Ltd. 1978; Bidwell 1977). Procurement policies enacted by government, however, could also be applied to the private sector. Such policies would directly interfere with market choices and have "the potential to introduce inefficiencies that result in lower productivity and higher social costs" (Goddard 1975: 155). The trade-off in this instance is the presumed assistance to recycling and the public good versus the interference with the market and freedom of choice.

WHICH POLICIES TO USE?

As has been discussed previously, several methods can be used to encourage reclamation and recycling. The choice between different methods or combinations of methods should consider:

1) the effectiveness with which the instrument will achieve the desired aim,

2) unwanted side effects that cause the loss of other benefits, set against the savings from additional recycling, and

3) the level of outlay and administrative costs that the action involves (Environmental Resources Ltd. 1978).

The social preference is for methods "that are predictable in effect, of lower cost to operate, are decentralized, are neutral" (Goddard 1975: 150) and that have low negative employment impacts.

There is also a major philosophical choice to be considered. This is whether the preference is for carrots or sticks, rewards or penalties, in providing incentives for recycling. It may be that a combination of approaches (for example, fines for willful littering plus a reward for returning beverage containers to a depot) is the appropriate solution.

Not all the characteristics preferred by society are consistent with each other, and the relative advantages of any one policy instrument depend upon the point of application in the economy. Consider an excise tax applied at the extraction stage of materials flow, for example, the cutting of trees. The administrative costs of the tax are relatively low, but materials not contributing to the perceived environmental problem (for example, lumber) are also affected by the tax and thus it is not very neutral. The application of the tax more towards the discard end of materials flow may have greater neutrality, but at greater administrative cost (Goddard 1975).

For any one problem to be tackled, an analysis of the costs associated with the use of a variety of methods at various points of intervention should be conducted. The point at which the sum total of costs is least would be the most desirable place in the economy to apply the methods to encourage recycling. A detailed analysis of costs to determine the most appropriate control points for applying the policies, however, may be very difficult if environmental and other social costs are to be properly accounted for. Where decisions cannot wait for a full cost analysis of options, decision-makers must rely on good judgment. The importance of well-developed judgment skills under such circumstances is emphasized because of the scarcity of case examples available for guidance.

5. CONCLUDING REMARKS

Failure to reflect the whole of private and social costs of goods moving through the market is considered to be the reason for much of the environmental pollution of the modern world. Recycling of materials promises enhanced prospects for resource conservation and a cleaner environment, but it is not a cure-all. First, recycling cannot offer a cleaner environment in all ways. Waste products are generated regardless of whether or not recycling is practised. Lower water quality might have to be traded off for better air quality, for example, for a net gain in environmental quality. More significantly, the potential savings in scarce resources and the cleaner environment offered by recycling represent a gain in supply equivalent to only a few years, perhaps enough time to find better technological solutions to these problems or to smooth the transition to new products. On a global basis, population growth and per-capita demands for materials must slow in order for the benefits of recycling to be of any long-term benefit. Within a systems context, recycling is a significant, though only one, component of the solution to today's environmental problems.

This report, *Economic Barriers to Recycling*, has identified a number of policies that may be used alone or in various combinations to remove supply- and demand-related barriers that discourage recycling. Any one of the policies discussed is not best in all circumstances. Only after extensive study of the effectiveness of a policy and its economic and social costs can informed and appropriate decisions be made about its application. However, when appropriate data are absent, some of the principles outlined in this report can be useful in guiding the decision-making process. The costs and difficulties of assembling appropriate data suggest that cautious experimentation with various policy methods would be appropriate so that an accumulating information base can be used to modify the mix of policies needed to encourage recycling.

The evaluations of policies found within *Economic Barriers to Recycling*, however, are not beyond dispute. Indeed, the report may pose as many questions as it originally set out to answer. The examples cited are often based on experience elsewhere, developed in conditions that are not necessarily applicable in Alberta. Some of the policies discussed are already used in Alberta, for example, a deposit-refund system for beverage containers. In those cases, readers of this report will be able to draw upon their own experience to identify for the panel conducting the public hearings on recycling their likes and dislikes of the policies, and to make recommendations regarding the application of such policies. Much of the analysis is based on the premise that recycling should be encouraged by making it more profitable for the business sector, since a substantial private recycling sector already exists and the business sector is likely to recycle products most efficiently if barriers to its development are removed or incentives to its growth are implemented. Would you want to see the government support for beverage container recycling removed and the subsidies provided used for a different purpose? Or perhaps you believe that if government subsidies for waste disposal (municipal garbage pick-up) and for recycling were both to be eliminated the market would sort out the appropriate levels of recycling and waste disposal?

The questions themselves and the answers to them stem from perceptions and value judgments that vary with different people. No one person has all the right answers. It is important that the Environment Council panel on recycling hear your opinions, so that it can make recommendations about the direction for recycling in Alberta that are collectively best for our society. The Environment Council of Alberta will be listening with keen interest to your concerns and suggestions.

Glossary

Capital Gains Provisions

Assets that have appreciated in value and are sold are subject to a capital gains tax. The tax, however, is applied on one-half of the gain in appreciated value, and amounts to a lesser rate of taxation than on some other forms of income. In addition, a proposed amendment to the Income Tax Act will allow a once-only exemption on the first $500,000 of capital gains.

Cullet

Pieces of cleaned, crushed, and sorted glass, otherwise discarded, used in glass-making to hasten the melting of virgin silica.

Depletion Allowances

Depletion allowances are tax deductions based on the cost of finding and developing natural resources. The depletion itself is not a cash outlay, but in Canada the deduction allowed for depletion is based on part of the money spent to find new natural resources.

Elasticity

Elasticity is the change in supply or demand for a good or service consequent to a change in price. A good or service is said to be highly elastic if price changes result in significant changes in supply or demand. When the supply of or demand for a good or service shows little change with significant price changes, the good or service is said to have low elasticity or is said to be inelastic.

Old Scrap

Old scrap is scrap recovered from used products, including post-consumer waste. Unlike prompt scrap, the composition and level of contamination of old scrap are often unknown.

Prompt Scrap

Prompt scrap is scrap returned from fabricators of products to producers of materials, for example, the clippings and edgings from a printing shop (the fabricator) returned to a paper mill (the producer). Prompt scrap usually has a known composition and level of contaminants.

Regressive Tax

A regressive tax is one that more harshly impacts low-income earners than high-income earners.

Royalty Payment

In the context of this report, a royalty is a payment to government by resource companies for the right to extract natural resources.

Severance Taxes

Severance taxes are taxes levied at the point of extraction or harvest of a natural resource in proportion to the value of natural resource taken.

Vertical Integration

The control of successive stages of production and distribution of goods by one company. For example, a company that owns farms, processes the farm produce, and owns its own distribution outlets is vertically integrated.

References

Adamson, V.F. 1984. *Breaking the Barriers. A Study of Legislative and Economic Barriers to Industrial Waste Reduction and Recycling.* Canadian Environmental Law Research Foundation and the Pollution Probe Foundation. Toronto. 100 pages plus appendices.

Alberta Environment. 1979. *Recycling in Alberta: An Outline.* Waste Management Branch, Alberta Department of the Environment. Edmonton. 24 pages.

Anderson, F.R., A.V. Kneese, P.D. Reed, S. Taylor, and R.B. Stevenson. 1977. *Environmental Improvement through Economic Incentives.* Resources for the Future, Inc., Washington, D.C. Baltimore: The John Hopkins University Press. 195 pages.

Anderson, R.C. 1977. "Recycling Policy: Basic Economic Issues." In *Resource Conservation: Social and Economic Dimensions of Recycling*, D.W. Pearce and I. Walter, eds., pages 158-171. New York: New York University Press.

Backman, G.C. 1984. "The Metals Marketplace." In *Proceedings, 1st Prairie Recycling Conference*, pages 53-56. Environmental Protection Services, Alberta Department of the Environment. Edmonton. In preparation.

Bidwell, R. 1977. "Recycling Policy: An International Perspective." In *Resource Conservation: Social and Economic Dimensions of Recycling*, D.W. Pearce and I. Walter, eds., pages 172-190. New York: New York University Press.

Bingham, T.H. 1977. "Allocative and Distributive Effects of a Disposal Charge on Product Packaging." In *Resource Conservation: Social and Economic Dimensions of Recycling*, D.W. Pearce and I. Walter, eds., pages 144-157. New York: New York University Press.

Bohm, P. 1981. *Deposit-Refund Systems: Theory and Applications to Environmental, Conservation, and Consumer Policy.* Resources for the Future, Inc., Washington, D.C. Baltimore: The John Hopkins University Press. 175 pages.

Bower, B.T. 1975. "Economics of Residuals Use." In *Mineral Resources and the Environment. Supplementary Report: Resource Recovery from Municipal Solid Wastes*, pages 397-411. Committee on Mineral Resources and the Environment (COMRATE). Washington, D.C.: National Academy of Sciences.

----- 1977. "Economic Dimensions of Waste Recycling and Re-use: Some Definitions, Facts, and Issues." In *Resource Conservation: Social and Economic Dimensions of Recycling*, D.W. Pearce and I. Walter, eds., pages 1-19. New York: New York University Press.

Butlin, J.A. 1977. "The Prices of Secondary Materials and Recycling Effort." In *Resource Conservation: Social and Economic Dimensions of Recycling,* D.W. Pearce and I. Walter, eds., pages 207-228. New York: New York University Press.

Chandler, W.U. 1983. *Materials Recycling: The Virtue of Necessity.* Worldwatch Paper 56. Worldwatch Institute. Washington, D.C. 52 pages.

City of Calgary Engineering Department. 1985. *Annual Report 1984.* The City of Calgary. Calgary. Various pagination.

Conn, W.D. 1977. "Consumer Product Life Extention in the Context of Materials and Energy Flows." In *Resource Conservation: Social and Economic Dimensions of Recycling,* D.W. Pearce and I. Walter, eds., pages 127-143. New York: New York University Press.

Cook, E. 1976. *Man, Energy, Society.* San Francisco: W.H. Freeman and Company. 478 pages.

Edmonton Water and Sanitation. 1985. *Annual Report 1984.* The City of Edmonton. Edmonton. 36 pages.

Environmental Resources Ltd. 1978. *The Economics of Recycling.* Consumer Protection Service of the Commission of the European Communities, Luxemburg. London: Graham and Trotman Limited. 167 pages.

Freeman III, A.M., R.H. Haveman, and A.V. Kneese. 1973. *The Economics of Environmental Policy.* Toronto: John Wiley and Sons, Inc. 184 pages.

Goddard, H.C. 1975. *Managing Solid Wastes: Economics, Technology, and Institutions.* New York: Praeger Publishers. 368 pages.

Hall, Jr., J.R. and R.L. Ackoff. 1972. "A Systems Approach to the Problems of Solid Waste and Litter." *Journal of Environmental Systems* 2(4): 351-364.

Hare, M.J. 1983. *An Economic and Environmental Assessment of Alberta's Unique Beverage-Container Redemption System: Executive Summary.* Waste Management Branch, Alberta Department of the Environment. Edmonton. 42 pages.

Kelly, B. 1974. *Energy Conservation and Solid Waste Management.* Paper No. 4. Office of Energy Conservation, Canada Department of Energy, Mines and Resources. Ottawa. 7 pages.

Krahn, H. 1983. *Environmental Issues in Alberta: The Opinions of Edmonton Residents.* RMD Report 82/A. Research Management Division, Alberta Department of Environment. Edmonton. 25 pages.

MIR Information Research Ltd. 1981. *Public Perceptions of the Environment in Alberta.* Environment Council of Alberta. Edmonton. 33 pages plus appendices.

Office of Technology Assessment (OTA). 1979. *Materials and Energy From Municipal Solid Waste : Resource Recovery and Recycling from Municipal Solid Waste and Beverage Container Deposit Legislation.* Washington, D.C.: U.S. Government Printing Office. 284 pages.

Ontario Recycling Update. 1985. 5(3): 1-3 (May-June 1985).

Organisation for Economic Co-operation and Development (OECD). 1978. *Beverage Containers : Re-Use or Recycling.* Organisation for Economic Co-operation and Development. Paris. 159 pages.

----- 1979. *Waste Paper Recovery.* Organisation for Economic Co-operation and Development. Paris. 160 pages.

----- 1981. *Economic Instruments in Solid Waste Management.* Organisation for Economic Co-operation and Development. Paris. 193 pages.

Page, T. 1977. "Intertemporal and International Aspects of Virgin Materials Taxes." In *Resource Conservation : Social and Economic Dimensions of Recycling,* D.W. Pearce and I. Walter, eds., pages 63-81. New York : New York University Press.

Pilsworth, D.S. 1984a. *Waste Glass : A National and Provincial Profile.* Environment Protection Service, Canada Department of the Environment. Ottawa. 106 pages.

---- 1984b. *Waste Paper Data : A National Profile.* Environmental Protection Service, Canada Department of the Environment. Ottawa. 144 pages.

Radetzki, M. and C. Van Duyne. 1985. "The Demand for Scrap and Primary Metal Ores After a Decline in Secular Growth." *Canadian Journal of Economics* 18(2): 435-449.

Resource Recycling. Journal of Recycling, Reuse, and Waste Reduction. 1985. 4(1) (March-April 1985).

Smith, Jr. F.L. 1977. "Pollution Charges: The Practical Issues." In *Resource Conservation : Social and Economic Dimensions of Recycling,* D.W. Pearce and I. Walter, eds., pages 82-102. New York: New York University Press.

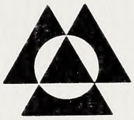
Taylor, P. 1982. *The Barriers to Recycling – An Updated Discussion Paper.* The Secondary Resources Development Council. Toronto. 34 pages plus appendices.

Wolbeck, B. 1977. "Secondary Materials and Economic Growth: Needs and Measures for a Comprehensive Policy." In *Resource Conservation : Social and Economic Dimensions of Recycling,* D.W. Pearce and I. Walter, eds., pages 23-32. New York: New York University Press.

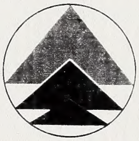
World In Figures, The. 1981. Third edition. Detroit: Gale Research. 294 pages.

About Our Logo

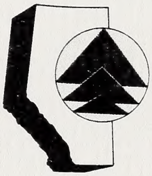
Alberta
ENVIRONMENT COUNCIL OF ALBERTA



Over the past two decades, the logo of the Environment Council of Alberta has shown three overlapping triangles as representing the foundations of our environment: land, air, and water. These triangles also represent the three groups with which the ECA interacts: industry, government, and the public. The three triangles intersect to form a circle symbolizing the biosphere. The small triangle in the centre of the circle symbolizes these three groups joining together to work for the conservation of our environment.



In 1980, the overlapped triangle motif was used by the World Conservation Strategy to represent the three primary objectives of that document. The Alberta Conservation Strategy incorporated the triangle motif into its logo by overlaying the WCS triangles onto a three dimensional outline of Alberta. This combination of triangles with the readily identifiable outline of provinces, nations, and regions has marked conservation strategies around the world.



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